

The University of Chicago

ECOLOGICAL STUDIES IN THE
LOWER ILLINOIS RIVER
VALLEY

A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE BIOLOGICAL
SCIENCES IN CANDIDACY FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF BOTANY

1931

By
LEWIS MacDONALD TURNER

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ECOLOGICAL STUDIES IN THE LOWER ILLINOIS RIVER VALLEY

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 470

LEWIS M. TURNER¹

(WITH ONE FIGURE)

Introduction

The central section of Illinois lies between 39° and 41° north latitude. Ecological studies were made adjacent to the Illinois River, in the southwestern part of this section, in Jersey, Calhoun, Greene, and southern Pike counties.

Several factors have contributed to the disturbance of the native flora on the floodplain or bottomland along the Illinois River in the region of this investigation. The two lower dams (10) in the river have raised the water level of the lakes. Discharge of water from the Chicago drainage canal (1, 10) has increased the average water level in this section 2.5–3 feet. Levees (10) have been constructed in many places for the purpose of reclaiming bottom lands for agriculture. The continuity of these levee areas is occasionally interrupted either because of lack of construction or because of the entry of tributaries into the river. Where these gaps occur the land is subject to overflow, and hence is generally not cultivated. These are the only areas representing the prelevee era of the valley, and here the flora has, to a large extent, retained its primitive condition. Such primitive flora was observed at the mouth of Apple Creek.

¹ Research paper no. 368, Journal Series, University of Arkansas.

The field work done in 1926 was partly financed by the Sigma Xi scientific society.

Physiography and geology

The Illinois River (2, 9), formed by the junction of the Des Plaines and Kankakee rivers in northeastern Illinois, flows 273 miles across the state in a southwesterly direction and joins the Mississippi River at Grafton. The fall of the river from LaSalle to its mouth, a distance of 223 miles, is only 33 feet (1). Its floodplain or bottomland is bounded by bluffs or hills, and it varies from 1.5 to 7 miles in width, averaging about 4 miles within the range of this study.

The bottomland of the lower valley of the Illinois River has been filled to a greater depth than its upper valley (1). Here the immediate banks of the stream are high, and although the lakes are smaller and fewer than in the upper valley, many of them lie 10 feet or more above the river when the water is low.

The lakes of the floodplain are not of the oxbow type. They have been formed by the impounding of water brought about by the differential deposition of silt, and by the formation of natural levees. These lakes lie, for the most part, in the lower backwater areas of the floodplain. They occur both in the forest and in the wet prairie. The lakes have been classified as permanent and temporary. Where there are smaller exposed surfaces of water these areas are called ponds or sloughs. The lakes receive their water supply from springs or small tributaries to the river. The permanent lakes are deep and poorly drained. The temporary lakes are made shallow by frequent deposits of silt. They become dry during part of the year, except in extremely wet years. During the exceedingly dry year of 1931 some of the "permanent" lakes also became dry.

In the region studied, the rocks (9) immediately underlying the upper soil layers of loess and loam are Mississippian limestone, containing some cherty and oolitic material and overlying shale of the same epoch. The bluffs at the sides of the river valley, throughout the area, have this same composition, with the exception of southern Calhoun County where there are small outcrops of Devonian and Silurian limestone overlying thicker beds of Ordovician (Richmond) limestone and shale. The section west of the Illinois River comprising Calhoun County and the southernmost part of Pike County were unglaciated (7, 8).

Ecological factors

CLIMATE

The physiographic features of central Illinois have little effect upon its climate (14). This section lies in the path of the main storm tracks that cross the country. Especially in winter these cause marked changes in the weather. The climatological data here given are from weather bureau stations in central Illinois to 1930, inclusive.

TEMPERATURE.—Central Illinois has a mean annual temperature of 52.6° F. The mean annual temperature in January, the coldest month, is 27.0°; in July, the warmest month, 76.4°. "The average minimum temperature for January is 18.4°; the average minimum temperature for July is 88.5°" (13). The crop-growing season averages 178 days.

PRECIPITATION.—The average annual rainfall is 36.65 inches with an annual range of 32.83 to 40.74 inches. Summer rainfall is sufficient to meet the requirement of the vegetation, although occasional droughts may occur. Most of the rainfall is of the local shower type. The snowfall averages 20.3 inches annually.

AIR MOVEMENT.—The prevailing winds in winter are from the northwest; during the summer they are from a southerly direction. Over limited areas occur occasional local squalls, and sometimes tornadoes, which cause great destruction.

SOILS

The present soils were derived from the residual material of the unglaciated area, glacial drift, and loess or windblown glacial material. Soils and their formation were studied particularly in Pike (7) and Calhoun (8) counties. Three topographical areas, each with its soil types, occur in this region: the upland, the bluff, and the bottomland.

UPLAND

The upland is characterized by two major soils, the upland prairie and the upland timber.

UPLAND PRAIRIE SOILS.—Because of the large quantity of roots of prairie grasses in the upland prairie soils, they are the richest in organic matter of all the soils in this region. These soil areas are rather

limited in extent. There is evidence that trees have recently grown on small areas of the prairie. Four types of prairie soils are found. The brown silt loam, although occupying little territory, has fair drainage and is the most extensive and fertile of the upland soils. Here is found the best assemblage of relic prairie plants. The sticky black clay loam (gumbo) is found on the poorly drained areas. The variation in content of organic matter indicates that the brown-gray silt loam on tight clay may have been timbered. It usually occurs between the timbered areas and the brown silt loam. The gray silt loam on tight clay occurs on level to slightly undulating topography. Because of the tight clay subsoil, it has poor drainage. It also contains the least organic matter of all the prairie soils.

UPLAND TIMBER SOILS.—The upland timber soils have a lower content of organic matter than the prairie soils. Yellow silt loam and yellow-gray silt loam, both derived from loess, are the principal upland timber soil types inland in Pike County (7). They are found on the somewhat level ridges of the rolling hills and on places badly broken by erosion. These broken areas are covered by plants of the oak-hickory association.

On the flat tops of the ridges and occupying only a small area is a light gray silt loam which is friable and porous. A layer of clay which is almost impervious to both air and water underlies this soil. This is a poorly drained but not a swampy soil.

The upland adjoining the Illinois River consists of a yellow-gray fine sandy loam on the less rolling land, and a yellow fine sandy loam on the hilly and very rolling, badly broken land of the deep loess areas. It is very pervious and hence has good drainage. The coarse sandy phases of this soil are found nearest the bluff.

The Calhoun County soil report (8) refers to the two soils just mentioned for Pike County as brownish yellow-gray silt loam and eroded silt loam. These are the only upland soils occurring in Calhoun County. The brownish yellow-gray silt loam increases in area toward the southeastern end of the county. All of the upland soils of this county were developed under a forest cover. They are derived from loess which overlies rock in most of the county. Almost no soil profile has been developed. It is fairly well developed only in the brownish yellow-gray silt loam. Active erosion has prevented the

development of a true soil profile in most of the county. These soils are friable and have no impervious strata in their profile; hence they have good drainage. Upon the uncultivated areas of this soil were oak, hickories, and white ash.

FLOODPLAIN OR BOTTOMLAND

BOTTOMLAND SOILS.—The valleys of the tributaries and small areas of bottomland of the Illinois River contain some soil deposits derived from the older glaciations. Most of the bottomland soils are of recent origin, however, and show no profile development. This is accounted for by annual recurrence of floods.

Floods (15) covering the floodplain to depths of 5 to 15 feet were recorded in 1883, 1892, 1893, 1903, 1904, 1908, 1913, 1916, 1920, 1922, 1926, 1927, and 1929 in the region near Kampsville. Minor floods submerging the bottoms to a depth of 1 to 5 feet occur almost annually. Most floods follow melting of the ice and snow in spring. Occasional floods occur in midsummer or fall. The spring floods usually come before the foliating period and seldom have any injurious effect except that caused by alluvial deposition.

The bottomland soils of the Illinois River seem to have three primary modes of origin: soils brought down from the upland by tributaries; coarse soils deposited by overflow of the river at flood time; and soils composed of the fine material that has settled in the back-water areas at the time of overflow. The following three soil types derived from these modes of origin have been recognized.

1. Soils carried down from the uplands are deposited as alluvial fans at the mouth of the tributaries. Brownish yellow-gray silt loam deposited upon the terraces at the base of the bluffs overlies sand and gravel. It is made up of a mixture of limestone fragments, hillside wash, and a small amount of river-deposited alluvium. It is a well drained soil and subject to overflow only in times of extremely high flood water. This soil type is always populated by the talus slope-floodplain transition forest and some members of the hillside talus slope and floodplain forests. Other deposits made near the mouths of the tributaries become a brown silt loam. This is covered either by forest or by floodplain prairie association.

2. The remaining soils are those derived primarily from the soils

deposited by the Illinois River. Mixed loam is the prevailing soil type in the belt bordering the river channel and on the islands. It consists of the coarsest materials deposited by the flood water. Typical floodplain forest grows upon this soil. Upon the rock or coarse soil of the islands a soil 1 to 5-6 feet in depth has developed. On slightly higher land is a deep brown clay loam containing some coarser material. There is evidence that the lower lying parts of this area were once populated rather extensively by the *Spartina michauxiana*-*Panicum virgatum* association. Most of this soil is now under cultivation. On the higher parts was found the floodplain forest.

3. In the low-lying, nearly level backwater areas, where lakes, ponds, and sloughs are commonly found, the soil is a drab clay loam. This has the finest texture and is the heaviest of all bottomland soils. It has poor drainage. Floodplain forest seldom occurs on this soil, but there is found typically the *Cephalanthus-Hibiscus militaris* association with occasional willows and green ash. Sometimes *Eleocharis* dominates this habitat, and more rare is the occurrence of the *Spartina michauxiana*-*Panicum virgatum* association.

BLUFF

BLUFF FACE.—The perpendicular face of the limestone bluffs provides a habitat for very few plant species. Residual and windblown soils accumulate in rock crevices where only a few herbaceous seed plants can grow.

TALUS SLOPE.—The talus slopes at the base of the bluffs consist of fragments of limestone and chert of varying size covered by residual soil and the brownish yellow silt loam washed down from the upland. Upon the surface is a rich mulch of partially decayed organic matter which, as in the case of the upland soils, does not combine to a great extent with the underlying soils. Such trees as red and hard maples, red and chestnut oaks, walnut and butternut, and basswood grow on these slopes.

HYDROGEN-ION CONCENTRATION

Soil samples for the determination of pH were taken at a depth of 10 inches. The upland soils had a hydrogen-ion concentration which ranged from neutral to pH 6. In both the upland forest and the prairie, pH 6.6 was common. The lowest pH values were found in

old fields in which there had been repeated cropping and excessive leaching.

While the floodplain soils are in general circumneutral, in this region the pH ranged from 7 to 7.8, indicating a more alkaline soil. This corresponds with the pH of the yearly flood water of the river, which has consistently tested 7.8. Floodplain lakes, ponds, and ditches also had a pH of approximately 7.8. The pH of the talus slope soil was 8.

Floristics

A transect of the Illinois River valley in the region investigated shows four sections: the upland, the bluff, the transition, and the floodplain. Each of these sections was divided into plant communities.

The plants² observed and recorded are divided into three groups: (1) large and small trees, and shrubs of greatest frequency, studied quantitatively and enumerated in the tables; (2) woody plants of infrequent occurrence; and (3) all herbs and some woody plants occurring in spring, summer, and fall aspects. The third group of plants has been assembled in three classes: class 1, the most common plants and those frequently occupying relatively large areas; class 2, the plants occurring fairly commonly but rarely occupying areas of wide extent; class 3, plants occurring occasionally. The order of arrangement for all species is from that of greatest to that of least frequency. Casual or rare plants are not listed.

PLANT COMMUNITIES

UPLAND

UPLAND PASTURES AND OLD FIELDS.—Because of the fragmentary occurrence and difficulty in identifying the upland prairie vegetation among the upland pastures and old fields, neither a quantitative evaluation nor a study of dominance and succession was made in this community. The data assembled, however, are of value because they give a partial record of the present condition of a plant community that is rapidly disappearing.

² Authorities for the species listed are those given in the seventh edition of GRAY'S Manual. The species of Gramineae were identified by Mrs. AGNES CHASE of the United States Department of Agriculture. Approximately 650 species of plants were collected, and a set was given to the Department of Botany at the University of Chicago.

HERBS

Spring

Class 1

Poa pratensis	E. philadelphicus
Trifolium repens	Potentilla canadensis
Rumex acetosella	Poa annua
Capsella bursa-pastoris	P. compressa
Erigeron pulchellus	

Class 2

Melilotus alba	P. major
M. officinalis	Oxalis stricta
Stellaria media	Apocynum cannabinum
Antennaria plantaginifolia	Achillea millefolium
Medicago sativa	Verbascum blattaria
Plantago lanceolata	

Class 3

Pentstemon gracilis	Phlox divaricata
Asclepias quadrifolia	Comandra umbellata
Silene antirrhina	Monarda bradburiana
Physalis virginiana	Blephilia hirsuta
Arabis drummondi	Polygonatum commutatum
Fragaria virginiana	Scutellaria versicolor
Amorpha canescens	

Summer

Class 1

Erigeron spp.	Stellaria media
Ipomoea hederacea	Rudbeckia hirta
Verbena stricta	Plantago aristata
Euphorbia corollata	Petalostemum purpureum
Verbascum thapsus	Cirsium lanceolatum
Strophostyles helvola	Silphium integrifolium

Class 2

<i>Agrostis hyemalis</i>	<i>Desmodium illinoense</i>
<i>Hypericum punctatum</i>	<i>Monarda fistulosa</i>
<i>Bouteloua curtipendula</i>	<i>Ambrosia bidentata</i>
<i>Solidago radula</i>	<i>Phleum pratense</i>
<i>Sorghum halapense</i>	<i>Asclepias tuberosa</i>

Class 3

<i>Daucus carota</i>	<i>Nepeta cataria</i>
<i>Solanum carolinense</i>	<i>Verbena bracteosa</i>
<i>S. nigrum</i>	<i>Achillea millefolium</i>
<i>Asclepias purpurascens</i>	<i>Croton capitatus</i>
<i>Lechea tenuifolia</i>	<i>Physalis heterophylla</i>
<i>Oxalis corniculata</i>	<i>Psoralea tenuiflora</i>
<i>Ruellia ciliosa</i>	<i>Kuhnia eupatorioides</i>
<i>Verbena urticaefolia</i>	<i>Cichorium intybus</i>
<i>Petalostemum candidum</i>	<i>Acerates floridana</i>
<i>Setaria glauca</i>	<i>Pycnanthemum muticum</i>
<i>Coreopsis tripteris</i>	<i>Tripsacum dactyloides</i>
<i>Astragalus canadensis</i>	<i>Cuphea petiolata</i>
<i>Phlox pilosa</i>	<i>Panicum capillare</i>
<i>Anthemis cotula</i>	<i>Pentstemon grandiflorus</i>

Fall

Class 1

<i>Eupatorium torreyanum</i>	<i>Panicum agrostoides</i>
<i>E. sessilifolium</i>	<i>Sporobolus asper</i>
<i>Andropogon furcatus</i>	<i>Andropogon scoparius</i>
<i>Eragrostis cilianensis</i>	<i>Helianthus hirsutus</i>

Class 2

<i>Gerardia tenuifolia</i>	<i>Aster oblongifolius</i>
<i>Aster anomalus</i>	<i>Cirsium arvense</i>
<i>Eragrostis caroliniana</i>	<i>Lespedeza capitata</i>
<i>Liatris cylindracea</i>	<i>Sorghastrum nutans</i>
<i>L. scariosa</i>	<i>Solidago</i> spp.
<i>Cassia nictitans</i>	

Class 3

<i>Croton monanthogynus</i>	<i>L. virginica</i>
<i>Polanisia trachysperma</i>	<i>L. frutescens</i>
<i>Lespedeza repens</i>	<i>Elymus canadensis</i>
<i>L. striata</i>	<i>Liatris pycnostachya</i>

SHRUBS, PERMANENT INVADERS OF OPEN AREAS

<i>Rhus toxicodendron</i>	<i>Symphoricarpos orbicula-</i>
<i>R. canadensis</i>	<i>tus</i>
<i>R. glabra</i>	<i>Corylus americana</i>
<i>Cornus asperifolia</i>	<i>Sassafras variifolium</i>
<i>Sambucus canadensis</i>	<i>Rosa cinnamomea</i>

At the beginning of spring in this prairie region a considerable number of introduced species appear, many of which are common weeds. As the season progresses, however, the aspect of the vegetation changes and by midsummer there are many typical prairie species. Most of these are apparently survivors of the previously widespread prairie of the central states. Several are western species, some of which are at the eastern borders of their range; others are probably extraneous.

UPLAND FOREST.—The transect method was used in making a quantitative study of the woody plants in the various plant communities. Each quadrat was 50 meters in length and 10 meters in width, and fifty quadrats were studied in each plant community. A record was made only of trees 6 inches or more in diameter, breast high, and of shrubs and small trees 6 feet or more in height. The data in the tables list the species and give: (1) the number of quadrats, in the 50 quadrats, in which each species is found; (2) the average number of individuals in a quadrat, computed on a 50-quadrat basis; and (3) the dominance index. The dominance index was obtained by multiplying the average number of quadrats in which a species was found by the average number of individuals of that species in a quadrat.

In the upland forest (table I) the 50 quadrats were distributed over 20 miles of upland bordering the Illinois River. Most of the

woodlands of the region have been cut over, burned, and grazed; hence their resemblance to the original stand is questioned. From the size and apparent age of the trees, one may conclude that some of them in a few of the timber tracts persist from the virgin stand.

TABLE I
QUANTITATIVE EVALUATION OF TREES AND SHRUBS OF
GREATEST FREQUENCY IN UPLAND FOREST

SPECIES	NO. QUADRATS CONTAINING SPECIES	AVERAGE NO. INDIVIDUALS PER QUADRAT	DOMINANCE INDEX
Trees			
<i>Quercus alba</i>	50	10.0	500
<i>Q. velutina</i>	50	4.2	210
<i>Q. rubra</i>	50	3.5	175
<i>Carya alba</i>	47	3.3	155
<i>C. ovata</i>	38	4.0	152
<i>Acer saccharum</i>	20	2.7	54
<i>Fraxinus americana</i>	23	1.8	41
<i>Acer rubrum</i>	14	2.3	32
<i>Juglans nigra</i>	19	1.6	30
<i>Quercus muhlenbergii</i>	5	1.6	8
<i>Morus rubra</i>	5	1.0	5
Smaller trees and shrubs*			
<i>Cercis canadensis</i>	16	4.0	64
<i>Cornus florida</i>	25	2.5	61
<i>Sassafras variifolium</i>	11	4.0	44
<i>Rhus glabra</i>	3	8.0	24
<i>Viburnum rufidulum</i>	7	3.0	21
<i>Cornus asperifolia</i>	8	1.0	8

* *Ceanothus americanus* is the most common and widely distributed of the shrubs but was not recorded because of its small size.

The tree species as recorded by the dominance index, together with the list of woody and herbaceous plants, indicate that the upland forest is a typical oak-hickory forest association.

TREES OF INFREQUENT OCCURRENCE

<i>Diospyros virginiana</i>	<i>Ulmus americana</i>
<i>Aesculus glabra</i>	<i>U. fulva</i>
<i>Prunus serotina</i>	<i>Juglans cinerea</i>
<i>P. americana</i>	<i>Quercus macrocarpa</i>
<i>Juniperus virginiana</i>	

SMALL TREES AND SHRUBS OF INFREQUENT OCCURRENCE

<i>Rhus canadensis</i>	<i>Pyrus ioensis</i>
<i>Rubus recurvans</i>	<i>Zanthoxylum americanum</i>
<i>R. villosus</i>	<i>Rosa setigera</i>
<i>Hydrangea arborescens</i>	<i>Viburnum prunifolium</i>
<i>Ribes gracile</i>	<i>Ptelea trifoliata</i>
<i>Crataegus</i> spp.	<i>Staphylea trifolia</i>
<i>Evonymus atropurpureus</i>	<i>Rhamnus lanceolata</i>
<i>Amelanchier canadensis</i>	

VINES

<i>Rhus toxicodendron</i>	<i>Celastrus scandens</i>
<i>Psedera quinquefolia</i>	<i>Vitis aestivalis</i>
<i>Smilax rotundifolia</i>	<i>Tecoma radicans</i>
<i>S. hispida</i>	

HERBS

Spring

Class 1

<i>Claytonia virginica</i>	<i>Ranunculus hispidus</i>
<i>Phlox divaricata</i>	<i>Trillium recurvatum</i>
<i>Podophyllum peltatum</i>	<i>Dicentra canadensis</i>
<i>Galium</i> spp.	<i>Viola sororia</i>
<i>Phlox pilosa</i>	<i>Erythronium albidum</i>
<i>Dicentra cucullaria</i>	

Class 2

<i>Asarum canadense</i>	<i>Uvularia grandiflora</i>
<i>Triosteum aurantiacum</i>	<i>Comandra umbellata</i>
<i>Antennaria plantaginifolia</i>	<i>Hepatica triloba</i>
<i>Erigeron pulchellus</i>	<i>Camassia esculenta</i>
<i>Potentilla canadensis</i>	<i>Nothoscordum bivalve</i>
<i>Monarda bradburiana</i>	<i>Uvularia perfoliata</i>
<i>Sanicula gregaria</i>	

Class 3

Lithospermum canescens	Oxalis violacea
Hybanthus concolor	Pentstemon gracilis
Oxalis stricta	Polygonatum commutatum
Asclepias quadrifolia	Physalis subglabrata
Sphenopholis obtusata	Scutellaria versicolor
Brauneria pallida	Allium canadense
Apocynum cannabinum	Castilleja coccinea
var. pubescens	Dodecatheon meadia
Poa pratensis	Actaea rubra
Actaea alba	Viola rafinesquii

Summer

Class 1

Amorpha canescens	Euphorbia corollata
Galium circaezans	Cuscuta coryli
G. pilosum	Gillenia stipulata
Cuscuta cuspidata	

Class 2

Monarda fistulosa	Physalis pubescens
M. punctata	Psoralea onobrychis
Gerardia grandiflora	Anemone virginiana
Pycnanthemum flexuosum	Petalostemum purpureum

Class 3

Asclepias purpurascens	Geum canadense
Oxalis corniculata	Hystrix patula
Asclepias verticillata	Eupatorium urticaefolium
Petalostemum candidum	Eryngium yuccifolium
Ruellia ciliosa	Lilium philadelphicum

Fall

Class 1

Eupatorium torreyanum	Solidago spp.
Desmodium sessilifolium	Helianthus hirsutus

Class 2

Gerardia tenuifolia	Baptisia leucantha
Vernonia altissima	Aster spp.

Class 3

Cassia nictitans	L. squarrosa
Liatris cylindracea	L. scariosa

BLUFF

LIMESTONE BLUFF.—There are two groups of plants commonly found in the limestone bluff habitat, those growing upon the bare rock or in crevices containing little or no soil and those living in crevices or depressions having considerable soil. All divisions of the plant kingdom occurred among the first group of plants. The lichens and mosses were unidentified. Two genera of ferns were named, *Pellaea atropurpurea* and *Cheilanthes feei*. Although usually requiring more soil, *Heuchera americana*, *Houstonia* sp., and *Elymus canadensis* were the seed plants found in this group.

The second plant group here listed is larger, and it is more variable in its soil requirements than is the first plant group. Among the species listed are those which are also found on the hilltop and in the talus slope forest.

WOODY PLANTS

Class 1

Psedera quinquefolia	Celastrus scandens
Rhus toxicodendron	Vitis aestivalis

Class 2

Hydrangea arborescens	Staphylea trifolia
Lonicera sempervirens	Juniperus virginiana
Rhus canadensis	Cercis canadensis
Ptelea trifoliata	Cornus asperifolia

Class 3

Rhamnus lanceolata	Ceanothus americanus
Viburnum prunifolium	Gymnocladus dioica
Amelanchier canadensis	

HERBS

Spring

Class 1

<i>Aquilegia canadensis</i>	<i>Pellaea atropurpurea</i>
<i>Houstonia lanceolata</i>	<i>Cheilanthes feei</i>
<i>Heuchera americana</i>	

Class 2

<i>Triosteum aurantiacum</i>	<i>Phlox pilosa</i>
<i>Comandra umbellata</i>	

Class 3

<i>Oxalis violacea</i>	<i>Monarda bradburiana</i>
<i>Dodecatheon meadia</i>	<i>Pentstemon gracilis</i>
<i>Oxalis stricta</i>	<i>Polygonatum commutatum</i>

Summer

Class 1

<i>Houstonia lanceolata</i>

Class 2

<i>Campanula americana</i>

Fall

Class 2

<i>Elymus canadensis</i>	<i>Solidago</i> spp.
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The spring flora in this plant community consists of but few species. These, however, constitute the largest number of herbaceous plants. The number of new species and of persisting plants diminishes throughout the summer, and by September the herbaceous vegetation has almost entirely disappeared.

TRANSITION

HILLSIDE-TALUS SLOPE FOREST.—Between the floodplain terraces and the bluffs there are steep slopes upon which grow the hillside-talus slope forest. The quantitative analysis of the woody vegetation of this forest is given in tables II and III.

Owing to the cutting of the red, white, and black oaks for use as timber and firewood, the dominance index of the tree species as given in table II probably does not give a picture of the virgin forest that

TABLE II
QUANTITATIVE EVALUATION OF TREES OF GREATEST FREQUENCY
IN HILLSIDE-TALUS SLOPE FOREST

SPECIES	NO. QUADRATS CONTAINING SPECIES	AVERAGE NO. INDIVIDUALS PER QUADRAT	DOMINANCE INDEX
<i>Acer saccharum</i>	50	10.2	510
<i>Quercus muhlenbergii</i>	48	7.1	341
<i>Q. rubra</i>	36	7.1	266
<i>Tilia americana</i>	46	3.7	170
<i>Juglans nigra</i>	42	3.5	147
<i>Gymnocladus dioica</i>	27	3.7	100
<i>Carya ovata</i>	30	2.5	75
<i>C. alba</i>	33	2.0	66
<i>Acer rubrum</i>	31	2.1	65
<i>Ulmus americana</i>	26	2.4	62
<i>Aesculus glabra</i>	20	2.3	46
<i>Juglans cinerea</i>	20	2.1	42
<i>Celtis occidentalis</i>	21	2.0	42
<i>Ulmus fulva</i>	25	1.5	38
<i>Quercus velutina</i>	8	4.0	32
<i>Robinia pseudo-acacia</i>	9	2.3	21
<i>Fraxinus americana</i>	17	1.2	20
<i>Carya glabra</i>	10	1.4	14

TABLE III
QUANTITATIVE EVALUATION OF SMALL TREES AND SHRUBS OF
GREATEST FREQUENCY IN THE HILLSIDE-
TALUS SLOPE FOREST

SPECIES*	NO. QUADRATS CONTAINING SPECIES	AVERAGE NO. INDIVIDUALS PER QUADRAT	DOMINANCE INDEX
<i>Cercis canadensis</i>	37	4.7	174
<i>Staphylea trifolia</i>	28	3.8	106
<i>Cornus asperifolia</i>	30	3.3	99
<i>Ptelea trifoliata</i>	21	4.7	99
<i>Asimina triloba</i>	16	2.8	45
<i>Cornus florida</i>	20	2.0	40
<i>Sassafras variifolium</i>	14	2.0	28
<i>Rhus glabra</i>	13	2.0	26
<i>Diospyros virginiana</i>	8	1.6	13
<i>Carpinus caroliniana</i>	5	2.0	10
<i>Ostrya virginiana</i>	4	2.0	8

* *Hydrangea arborescens* was not recorded because of its small size, although it is one of the most abundant and widespread shrubs in this forest.

occupied this plant community. Lists of the infrequent woody plants and of the herbs in the undergrowth are included in this study. A larger number of woody species, and possibly as many, if not more, herbaceous species are found here than in any other habitat in this region.

TREES OF INFREQUENT OCCURRENCE

<i>Prunus serotina</i>	<i>Carya illinoensis</i>
<i>Quercus alba</i>	<i>C. cordiformis</i>
<i>Morus rubra</i>	<i>Platanus occidentalis</i>
<i>Acer negundo</i>	<i>Gleditsia triacanthos</i>
<i>Quercus macrocarpa</i>	<i>Populus alba</i>
<i>Q. imbricaria</i>	
<i>Fraxinus pennsylvanica</i>	
var. <i>lanceolata</i>	

SMALL TREES AND SHRUBS OF INFREQUENT OCCURRENCE

<i>Rubus</i> spp.	<i>Crataegus</i> spp.
<i>Sambucus canadensis</i>	<i>Benzoin aestivale</i>
<i>Viburnum rufidulum</i>	<i>Ribes gracile</i>
<i>Amelanchier canadensis</i>	<i>Rhamnus lanceolata</i>
<i>Juniperus virginiana</i>	

VINES

<i>Rhus toxicodendron</i>	<i>Vitis vulpina</i>
<i>Psedera quinquefolia</i>	<i>Smilax rotundifolia</i>
<i>Menispermum canadense</i>	<i>Humulus lupulus</i>
<i>Vitis aestivalis</i>	<i>Celastrus scandens</i>
<i>Cissus ampelopsis</i>	<i>Clematis pitcheri</i>

HERBS

Spring

Class I

<i>Claytonia virginica</i>	<i>Trillium recurvatum</i>
<i>Ranunculus hispidus</i>	<i>Polystichum acrostichoides</i>
<i>Viola sororia</i>	<i>Geranium maculatum</i>
<i>Podophyllum peltatum</i>	<i>Adiantum pedatum</i>
<i>Phlox divaricata</i>	<i>Arisaema triphyllum</i>
<i>Aquilegia canadensis</i>	<i>Delphinium tricornis</i>

Dicentra cucullaria	Anemonella thalictroides
Galium pilosum	Onoclea sensibilis
Asarum canadense	Cystopteris fragilis

Class 2

Smilacina racemosa	Uvularia grandiflora
Dicentra canadensis	Dentaria laciniata
Polygonatum commutatum	Triosteum aurantiacum
Sanguinaria canadensis	Caulophyllum thalictroides
Anemone canadensis	Viola pubescens
Menispermum canadense	Aruncus sylvester
Geranium carolinianum	Mertensia virginica
Botrychium virginianum	Hydrophyllum virginia-
Osmorhiza claytoni	num
Sanicula gregaria	Asplenium acrostichoides
Cerastium arvense var. oblongifolium	

Class 3

Ruellia strepens	Arabis laevigata
Hepatica triloba	Oxybaphus nyctagineus
Hybanthus concolor	Heuchera americana
Osmorhiza longistylis	Cypripedium parviflorum
Smilax herbacea	Sphenopholis obtusata
Monarda bradburiana	Liparis liliifolia
Panax quinquefolium	Hydrastis canadensis
Pedicularis canadensis	Actaea rubra
Trillium grandiflorum	

Summer

Class 1

Podophyllum peltatum	Desmodium bracteosum
Phlox divaricata	Impatiens biflora
Galium spp.	I. pallida
Adiantum pedatum	Onoclea sensibilis
Aquilegia canadensis	Cystopteris fragilis
Polystichum acrostichoides	

Class 2

<i>Cuscuta coryli</i>	<i>Tradescantia reflexa</i>
<i>Aralia racemosa</i>	<i>Dioscorea villosa</i>
<i>Botrychium virginianum</i>	<i>Hydrophyllum virginianum</i>
<i>Campanula americana</i>	
<i>Eupatorium purpureum</i>	<i>Polymnia canadensis</i>
<i>Cryptotaenia canadensis</i>	<i>Aruncus sylvester</i>
<i>Asplenium acrostichoides</i>	<i>Scrophularia marilandica</i>
<i>Anemone virginiana</i>	<i>Phytolacca decandra</i>
<i>Phlox paniculata</i>	

Class 3

<i>Eupatorium urticaefolium</i>	<i>Sicyos angulatus</i>
<i>Aspidium marginale</i>	<i>Lilium canadense</i>
<i>Geum canadense</i>	<i>Scutellaria pilosa</i>
<i>Circaea lutetiana</i>	<i>Panax quinquefolium</i>
<i>Lobelia siphilitica</i>	<i>Hydrastis canadensis</i>
<i>Hystrix patula</i>	<i>Rudbeckia triloba</i>
<i>Heliopsis scabra</i>	<i>Cystopteris bulbifera</i>
<i>Gerardia flava</i>	<i>Polymnia canadensis</i> var.
<i>Gillenia stipulata</i>	<i>radiata</i>
<i>Actinomeris alternifolia</i>	

Fall

Class 1

<i>Eupatorium serotinum</i>	<i>Gnaphalium polycephalum</i>
<i>Kuhnia eupatorioides</i>	<i>Desmodium sessilifolium</i>

Class 2

<i>Setaria glauca</i>	<i>Conobea multifida</i>
<i>Cirsium lanceolatum</i>	<i>Actinomeris alternifolia</i>
<i>Aster</i> spp.	

Class 3

<i>Eupatorium sessilifolium</i>	<i>Digitaria sanguinalis</i>
<i>Brauneria purpurea</i>	<i>Cirsium discolor</i>
<i>Panicum praecocius</i>	<i>Panicum clandestinum</i>
<i>Anychia canadensis</i>	<i>Muhlenbergia sobolifera</i>
<i>Eupatorium urticaefolium</i>	<i>Brachyelytrum erectum</i>
<i>Cassia nictitans</i>	<i>Eragrostis capillaris</i>

TALUS SLOPE-FLOODPLAIN TRANSITION FOREST.—The floodplain terrace, which lies between the talus slope and the flat bottomland, slopes gently toward the river, and upon it grows the talus slope-floodplain transition forest.

In this transition zone is found a mixture of forest trees (table IV). The American elm, burr oak, pecan, sycamore, hackberry, green ash, honey locust, and soft maple are representative floodplain trees; while walnut, butternut, red bud, white ash, and Kentucky coffee

TABLE IV
QUANTITATIVE EVALUATION OF TREES OF GREATEST FREQUENCY
IN TALUS SLOPE-FLOODPLAIN TRANSITION FOREST

SPECIES	NO. QUADRATS CONTAINING SPECIES	AVERAGE NO. INDIVIDUALS PER QUADRAT	DOMINANCE INDEX
<i>Ulmus americana</i>	48	10	480
<i>Platanus occidentalis</i>	50	6.5	325
<i>Celtis occidentalis</i>	40	5	200
<i>Cercis canadensis</i>	33	3	99
<i>Acer saccharinum</i>	36	3.2	85
<i>Carya illinoensis</i>	27	2.8	76
<i>Acer negundo</i>	23	3	69
<i>Quercus macrocarpa</i>	27	2.3	62
<i>Gleditsia triacanthos</i>	21	1.8	58
<i>Cornus asperifolia</i>	17	3	51
<i>Gymnocladus dioica</i>	22	2	44
<i>Diospyros virginiana</i>	18	2	36
<i>Fraxinus americana</i>	16	2	32
<i>Juglans nigra</i>	18	1.3	23
<i>Tilia americana</i>	12	1.3	16
<i>Juglans cinerea</i>	8	1.5	12

bean are typical hillside-talus slope trees. Significant is the fact that the American elm, sycamore, burr oak, box elder, and hackberry attain their maximum concentration or dominance in this habitat.

TREES AND SHRUBS OF INFREQUENT OCCURRENCE

<i>Crataegus</i> spp.	<i>Prunus serotina</i>
<i>Carya cordiformis</i>	<i>Asimina triloba</i>
<i>Quercus muhlenbergii</i>	<i>Populus deltoides</i>
<i>Adelia acuminata</i>	<i>Sassafras variifolium</i>
<i>Salix longifolia</i>	<i>Sambucus canadensis</i>
<i>Ulmus fulva</i>	

VINES

<i>Psedera quinquefolia</i>	<i>Smilax hispida</i>
<i>Rhus toxicodendron</i>	<i>Tecoma radicans</i>
<i>Vitis vulpina</i>	<i>Menispermum canadense</i>
<i>Smilax rotundifolia</i>	<i>Cissus ampelopsis</i>

HERBS

Spring

Class 1

<i>Claytonia virginica</i>	<i>Ranunculus hispidus</i>
<i>Phlox divaricata</i>	<i>Smilacina racemosa</i>
<i>Podophyllum peltatum</i>	<i>Hydrophyllum virginia-</i> num
<i>Ranunculus septentrionalis</i>	<i>Arisaema dracontium</i>
<i>Delphinium tricornes</i>	<i>Amsonia tabernaemontana</i>
<i>Trillium recurvatum</i>	<i>Potentilla monspeliensis</i>
<i>Ranunculus abortivus</i>	<i>Veronica officinalis</i>
<i>Capsella bursa-pastoris</i>	<i>Arabis virginica</i>
<i>Cerastium arvense</i> var. ob- longifolium	<i>Veronica peregrina</i>
<i>Mertensia virginica</i>	<i>Chaerophyllum procum-</i> bens
<i>Anemonella thalictroides</i>	<i>Rumex acetosella</i>
<i>Viola sororia</i>	<i>Viola cucullata</i>
<i>Anemone canadensis</i>	<i>Osmorhiza claytoni</i>
<i>Arisaema triphyllum</i>	<i>O. longistylis</i>
<i>Geranium carolinianum</i>	

Class 2

<i>Solanum triflorum</i>	<i>Senecio integerrimus</i>
<i>Cerastium vulgatum</i>	<i>Botrychium virginianum</i>
<i>Specularia perfoliata</i>	<i>Apocynum cannabinum</i> var. pubescens
<i>Convolvulus sepium</i>	<i>Ruellia strepens</i>
<i>Viola rafinesquii</i>	
<i>Oxybaphus nyctagineus</i>	

Class 3

<i>Lythrum alatum</i>	<i>Plantago lanceolata</i>
<i>Smilax herbacea</i>	<i>Pedicularis canadensis</i>

<i>Bromus secalinus</i>	<i>Malva rotundifolia</i>
<i>Plantago virginica</i>	<i>Arabis patens</i>
<i>Marrubium vulgare</i>	<i>Amorpha fruticosa</i>
<i>Achillea millefolium</i>	<i>Festuca elatior</i>

Summer

Class 1

<i>Sicyos angulatus</i>	<i>Cassia chamaecrista</i> var.
<i>Campanula americana</i>	<i>robusta</i>
<i>Tradescantia pilosa</i>	

Class 2

<i>Impatiens biflora</i>	<i>Veronica virginica</i>
<i>Ruellia ciliosa</i>	<i>Eupatorium purpureum</i>
<i>Desmodium bracteosum</i>	<i>Phytolacca decandra</i>
<i>Clematis pitcheri</i>	

Class 3

<i>Prunella vulgaris</i>	<i>Saponaria officinalis</i>
<i>Silene stellata</i>	<i>Rudbeckia laciniata</i>
<i>Gerardia flava</i>	<i>Lobelia inflata</i>
<i>Leersia virginica</i>	<i>Anemone virginiana</i>
<i>Cacalia reniformis</i>	<i>Hystrix patula</i>
<i>Aspidium marginale</i>	<i>Verbascum thapsus</i>
<i>Polygonum setaceum</i>	<i>Nepeta cataria</i>
<i>Silphium perfoliatum</i>	

Fall

Class 1

<i>Eupatorium serotinum</i>	<i>Heliopsis scabra</i>
<i>Solidago serotina</i>	<i>Chenopodium glaucum</i>

Class 2

<i>Eupatorium perfoliatum</i>	<i>Humulus lupulus</i>
<i>Rudbeckia triloba</i>	<i>Cuscuta glomerata</i>

Class 3

<i>Eupatorium urticaefolium</i>	<i>Panicum clandestinum</i>
<i>Conoclea multifida</i>	<i>Muhlenbergia sobolifera</i>

<i>Brachyelytrum erectum</i>	<i>Croton glandulosus</i> var.
<i>Euphorbia dentata</i>	<i>septentrionalis</i>
<i>Sorghum halapense</i>	

FLOODPLAIN

The floodplain or bottomland includes the remaining lowland vegetation between the terrace and the channel of the Illinois River. This topographic unit has provided the best opportunity for the study of the hydrarch plant succession, which may be seen in forest, prairie, lake, river bank, and island plant communities.

TABLE V
QUANTITATIVE EVALUATION OF TREES OF GREATEST
FREQUENCY IN THE FLOODPLAIN FOREST

SPECIES	NO. QUADRATS CONTAINING SPECIES	AVERAGE NO. INDIVIDUALS PER QUADRAT	DOMINANCE INDEX
<i>Acer saccharinum</i>	48	8.7	418
<i>Ulmus americana</i>	50	6.4	320
<i>Carya illinoensis</i>	47	4.1	193
<i>Quercus palustris</i>	45	3.4	153
<i>Adelia acuminata</i>	36	3.7	133
<i>Crataegus</i> sp.....	36	3.2	115
<i>Celtis occidentalis</i>	38	3.0	114
<i>Fraxinus pennsylvanica</i> var. <i>lanceolata</i>	42	2.6	109
<i>Betula nigra</i>	23	3.0	69
<i>Gleditsia triacanthos</i>	16	2.0	32
<i>Diospyros virginiana</i>	16	1.6	26
<i>Populus deltoides</i>	12	2.0	24

FLOODPLAIN FOREST.—The habitat of the floodplain forest varied from the moister area bordering swamps, sloughs, or river bank to the higher, drier parts of the floodplain.

The dominance index of the floodplain forest (table V) shows that the soft maple and American elm are the dominant trees; pecan, hackberry, pin oak, swamp privet, and *Crataegus* are second in abundance; while river birch, honey locust, persimmon, and cottonwood occur in lesser abundance. The cottonwood, occurring most abundantly in moist or pioneer areas, was the pioneer tree of the floodplain forest. It persisted in the early stages of floodplain succession but was rarely found in areas where the climax or subclimax forest was established.

The pecan and pin oak were occasionally important, forming pure stands locally. The cutting of less desirable trees may account for this dominance of the pecan. In a few limited areas, north of the region studied, the pin oak occupied 40 per cent of the timber stand.

In early spring in the lower, wetter parts of the floodplain forest occur *Senecio glabellus* and *Radicula palustris*, and colonies of *Amsonia tabernaemontana*, *Erigeron*, and *Apocynum cannabinum*. The higher, better drained parts of this forest contain several species of *Ranunculus* (*R. septentrionalis* being the most common), *Phlox divaricata*, *Anemone* spp., *Podophyllum*, *Claytonia*, *Trillium*, *Geranium*, and *Viola* spp. Summer finds an abundance of *Polygonum*, *Steironema*, *Stachys*, *Chenopodium*, *Lysimachia*, and *Teucrium*. Species of these genera may be intermingled, or any one of them may form societies of varied extent. In late summer and fall composites dominate the habitat, and *Eupatorium serotinum* is the most abundant species. *Vernonia illinoensis* and *V. missurica* are conspicuous and important, and commonly form extensive societies in the more open lowland forest. In damp, well shaded parts of the forest, *Laportea* is frequently dominant, and associated with it as a subdominant may be *Impatiens biflora*. In September *Boltonia asteroides* is common in the more open areas, *Vernonia* spp. persist, *Matricaria suarcolens* appears, and *Physostegia virginiana* occurs along the forest edge. Species of *Solidago* and *Bidens* occur sparingly in the floodplain forest but are abundant in the adjacent floodplain prairie and abandoned fields.

TREES OF INFREQUENT OCCURRENCE

<i>Platanus occidentalis</i>	<i>Ulmus fulva</i>
<i>Carya laciniosa</i>	<i>Gleditsia aquatica</i>
<i>Morus rubra</i>	<i>Quercus lyrata</i>
<i>Quercus bicolor</i>	

VINES

<i>Smilax rotundifolia</i>	<i>Psedera quinquefolia</i>
<i>S. hispida</i>	<i>Rhus toxicodendron</i>
<i>Menispermum canadense</i>	<i>Tecoma radicans</i>
<i>Vitis vulpina</i>	<i>Cissus ampelopsis</i>
<i>V. cordifolia</i>	

HERBS

Spring

Class 1

<i>Radicula palustris</i>	<i>Arisaema triphyllum</i>
<i>Senecio glabellus</i>	<i>Geranium maculatum</i>
<i>Phlox divaricata</i>	<i>Anemone canadensis</i>
<i>Ranunculus septentrionalis</i>	<i>Trillium recurvatum</i>
<i>Potentilla monspeliensis</i>	<i>Hydrophyllum virginianum</i>
<i>Claytonia virginica</i>	
<i>Podophyllum peltatum</i>	<i>Arisaema dracontium</i>

Class 2

<i>Ranunculus abortivus</i>	<i>Apocynum cannabinum</i>
<i>Chaerophyllum procumbens</i>	var. <i>pubescens</i>
	<i>Amsonia tabernaemontana</i>
<i>Erigeron pulchellus</i>	<i>Viola cucullata</i>
<i>E. philadelphicus</i>	<i>V. pubescens</i>
<i>Galium triflorum</i>	<i>V. missouriensis</i>

Class 3

<i>Spermacoce glabra</i>	<i>Ranunculus micranthus</i>
<i>Iris versicolor</i>	<i>Dicentra canadensis</i>
<i>Ranunculus scleratus</i>	

Summer

Class 1

<i>Lysimachia quadrifolia</i>	<i>Stachys tenuifolia</i>
<i>Chenopodium album</i>	<i>Steironema ciliatum</i>
<i>Impatiens biflora</i>	<i>Teucrium canadense</i>

Class 2

<i>Ammannia coccinea</i>	<i>O. biennis</i>
<i>Amsonia tabernaemontana</i>	<i>Galium triflorum</i>
<i>Verbena urticaefolia</i>	<i>Polygonum pennsylvanicum</i>
<i>Eupatorium coelestinum</i>	
<i>Polygonum virginianum</i>	<i>Phytolacca decandra</i>
<i>Oenothera muricata</i> var. <i>canescens</i>	

Class 3

<i>Clematis pitcheri</i>	<i>Scutellaria lateriflora</i>
<i>Polygonum longistylum</i>	<i>Anthemis cotula</i>
<i>Solanum carolinense</i>	<i>Mentha piperita</i>
<i>Saururus cernuus</i>	

Fall

Class 1

<i>Eupatorium serotinum</i>	<i>Vernonia missurica</i>
<i>Laportea canadensis</i>	<i>Boltonia asteroides</i>
<i>Vernonia illinoensis</i>	

Class 2

<i>Solidago</i> spp.	<i>Boltonia asteroides</i> var. <i>de-</i>
<i>Cuscuta glomerata</i>	<i>currens</i>
<i>Helenium autumnale</i>	<i>Physostegia virginiana</i>
<i>Boehmeria cylindrica</i>	

Class 3

<i>Solanum nigrum</i>	<i>Aster paniculatus</i>
<i>Matricaria suaveolens</i>	<i>Lobelia cardinalis</i>

FLOODPLAIN PRAIRIE OR SAVANNA.—Unforested areas covered with prairie vegetation were commonly found on the floodplain. A zone of floodplain forest, from one-half to one mile in width, bordered the river channel and surrounded the lakes, whereas the prairie associations occurred on the somewhat higher ground between the river and the bluffs. *Spartina michauxiana* and *Panicum virgatum* constituted the dominant associations of this community.

Prairie areas on a floodplain were included in the investigations by BRENDAL (3) in the Illinois River valley near Peoria, by SAMPSON (11) along the Mississippi River near Savanna, and by CLEMENTS and WEAVER (4) along the western tributaries of the Mississippi River. GLEASON (5) has discussed the relationship of forest and prairie. The writer has discussed the prairie in detail (13).

FLOODPLAIN LAKES.—The lakes of the floodplain are classified as permanent and temporary forest lakes, and prairie lakes. The flood-

plain forest lakes are usually found in the forest near the river channel. The floodplain prairie lakes, lying in the wet prairie, are more frequently farther from the river channel, on higher ground, and shallower than the forest lakes. Each of these types of lakes has a flora which distinguishes it. Here the hydrarch succession from water through slough or swamp to the forest or to the prairie was easily determined.

PERMANENT FOREST LAKE.—Three definite zones of woody plants were observed between the floodplain forest and the permanent forest lake. The first zone retains honey locust and green ash from the floodplain forest. These occur in equal abundance with swamp privet (*Adelia acuminata*) and *Salix nigra*. With these are found also *S. fragilis*, *S. alba*, *S. longifolia*, and *S. amygdaloides*. Rarely does this zone escape submergence to a foot or more for several weeks each spring. The second zone is comprised of *Adelia acuminata* and button bush (*Cephalanthus occidentalis*), together with a few green ash and honey locust trees. Occasionally swamp privet dominates the zone, forming dense, almost impenetrable thickets. This zone is submerged in a foot or more of water from two to six months each year. The third zone consists of an irregular, more or less discontinuous belt of *Cephalanthus*. Except in extremely dry years, this zone is submerged to a depth of a few inches to three or more feet of water during the entire year.

The flora within and surrounding the floodplain lakes of the middle Mississippi River valley (6) and the upper Illinois River valley (3) is richer in species than is that of the floodplain lakes in the lower Illinois River valley. This may be accounted for by the fact that the condition of the habitat of the lakes in the lower Illinois valley is rendered unstable because of periodic floods which sweep the vegetation from these lakes.

The herbaceous plants occurring within and around the lakes of the lower valley have been separated into three groups: the aquatic plants, which include the floating and submerged plants; the amphibious plants, which comprise floating leaves, submerged, and emerged aquatic plants at the water's edge; and emerged aquatic and swamp plants. The species collected are given in the following list.

HERBS

Aquatic plants

Class 1

Lemna spp.	Spirodela polyrrhyza
Wolffia punctata	

Class 2

Ceratophyllum demersum	Potamogeton spp.
Elodea canadensis	

Class 3

Nelumbo lutea	Pontederia cordata
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Amphibious plants

Class 1

Polygonum pennsylvanicum	Rumex verticillatus
	R. crispus
P. longistylum	

Class 2

Alisma plantago-aquatica	Radicula nasturtium-aquaticum
Saururus cernuus	
Ludvigia palustris	Carex spp.

Class 3

Polygonum aquaticum	Cicuta maculata
Sium cicutaefolium	Sagittaria latifolia
Radicula aquatica	S. graminea

Emerged aquatics and swamp plants

Class 1

Radicula palustris	Lippia lanceolata
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Class 2

Myosurus minimus	Boehmeria cylindrica
Arabis virginica	

Class 3

Ranunculus micranthus	Ranunculus sceleratus
Thlaspi arvense	Iris versicolor
Spermacoce glabra	Equisetum arvense
Bidens bipinnata	Polygonum virginianum
Samolus floribundus	

TEMPORARY FOREST LAKES.—An opportunity is afforded in these shallow temporary forest lakes to observe a more advanced stage in hydrarch succession. What was at one time the outermost part of the lake bed is now occupied by floodplain forest trees. In a zone between these trees and the lake are growing ash, locust, maple, pin oak, and pecan trees. The center of some of these lakes may be occupied by swamp privet, willows, or button bush. These trees and shrubs impede the passage of flood water, and the obstruction causes the deposition of silt. The habitat becomes drier and thereby accelerates the development of the succession to the low-valley climax or floodplain forest.

While three groups of herbaceous plants were found, there were but few species in each group. Three genera of floating aquatic plants were seen, *Lemna*, *Wolffia*, and *Spirodela*. The amphibious plants commonly found were *Saururus*, *Polygonum*, *Jussiaea*, *Radicula*, *Rumex*, and *Sagittaria*. Since these lakes become dry in late summer, the fall aspect of the former water's edge and lake bed is different from that of the permanent forest lake. This space is now occupied by such weed genera as *Chenopodium*, *Bidens*, *Arabis*, *Thlaspi*, and *Rumex*.

FLOODPLAIN PRAIRIE LAKE.—The only woody species found on the wet prairie are an occasional willow tree or clumps of shrubs of willow or button bush. The numbers of herbaceous species of aquatic and amphibious plants of the floodplain prairie lake are about the same, but are more abundant than those of the forest lakes. *Saururus* does not grow here. The following list of herbaceous plants shows that the number of species of submerged and swamp plants of the wet prairie immediately surrounding these lakes is more than twice that of the temporary forest lakes.

HERBS

Emerged aquatic and swamp plants

Class 1

Eleocharis palustris	Chenopodium spp.
Iva ciliata	Eragrostis hypnoides
Xanthium canadense	Panicum virgatum
Juncus effusus	Lippia lanceolata
Rumex crispus	Spartina michauxiana
Alopecurus geniculatus	Bromus secalinus
Amaranthus spp.	Bidens cernua
Carex spp.	Scirpus fluviatilis
Echinochloa crusgalli	Sparganium eurycarpum

Class 2

Scirpus georgianus	Hibiscus militaris
Mimulus alatus	Ambrosia trifida
Alisma plantago-aquatica	Bidens comosa
Sagittaria latifolia	Eclipta alba
Cyperus spp.	

Class 3

Mimulus ringens	Vernonia fasciculata
Cicuta maculata	Ammannia coccinea
Steironema ciliatum	Portulaca oleracea
Eupatorium coelestinum	Penthorum sedoides

Eleocharis palustris is almost always present in this habitat, where it frequently either dominates the muddy shore line or forms dense mats in semi-dry lake beds. *Typha latifolia* occasionally forms rather extensive colonies. *Scirpus fluviatilis* completely fills a few shallow lakes, but it does not seem to have a wide distribution. *Nelumbo lutea* probably once had a wide distribution in the floodplain, judging from the number of seeds and floral receptacles found in dry lake beds. At present it is confined to a few small colonies in drainage sloughs and lake remnants.

Ponds and sloughs have fewer plant species than the larger lakes and are frequently dominated by a single species. They are often

occupied exclusively by *Typha*, *Sagittaria*, *Alisma*, *Polygonum*, *Sparganium*, *Hibiscus*, or *Rumex*.

RIVER BANK.—The plant succession of the river bank or shore line which lies between the water's edge and the floodplain forest may be seen in four zones. The study of the lower zones of this succession is simple, since the fluctuating water level effectively prevents the development of a widely diversified group of life forms.

Within the first zone, which is near the water's edge, seedlings of *Salix*, *Acer*, and *Populus* develop. Most of these seedlings eventually will be destroyed because the water level in most of these habitats is only relatively stable. Herbs growing in this zone are *Polygonum* and *Rumex*, *Eragrostis hypnoides*, *Lippia lanceolata*, *Juncus effusus*, *Eleocharis acicularis*, and *Xanthium canadense*. Less common herbs are *Jussiaea diffusa*, *Alisma plantago-aquatica*, *Sagittaria latifolia*, *Spermacoce glabra*, *Penthorum sedoides*, and *Eclipta alba*. In the second zone are found larger tree seedlings, or sprouts. This zone usually consists mostly of a somewhat dense stand of willows. There occurs in the third zone a series of belts of willow, each belt increasing in age and height as the distance from the water's edge becomes greater. Included in this zone also are a few swamp privets, cottonwoods, and maples. The pioneer trees of the river bank succession are the willow and the cottonwood. The fourth zone, which joins the floodplain forest, is the most stabilized. It is composed of mature willows, cottonwoods, hawthorns, and medium aged maples. *Vitis vulpina*, and to a lesser extent *V. palmata* and *V. cordifolia*, often form dense mats over the willow fringe. The trees that grow along the shore in the order in which they most commonly occur are *Salix nigra*, *S. fragilis*, *S. amygdaloides*, *S. discolor*, *Populus deltoides*, *Acer saccharinum*, *Adelia acuminata*, *Salix alba*, *Crataegus* sp., *Salix longifolia*, and *Platanus occidentalis*.

The following herbs were observed on the more stabilized zones of the river bank:

HERBS

Spring

Class 1

Radicula palustris
Senecio glabellus

Myosurus minimus
Equisetum arvense

Class 2

<i>Arabis virginica</i>	<i>Thlaspi arvense</i>
<i>Sisymbrium canescens</i>	<i>Lepidium virginicum</i>

Class 3

<i>Ranunculus abortivus</i>	<i>Chaerophyllum procumbens</i>
<i>Potentilla monspeliensis</i>	

Summer

Class 1

<i>Polygonum pennsylvanicum</i>	<i>Polygonum lapathifolium</i>
	<i>Rumex crispus</i>
<i>Chenopodium album</i>	<i>Chenopodium glaucum</i>
<i>Lippia lanceolata</i>	<i>Convolvulus sepium</i>

Class 2

<i>Spermacoce glabra</i>	<i>Polygonum longistylum</i>
<i>Oenothera muricata</i>	<i>P. aviculare</i>
<i>Gonolobus laevis</i>	<i>Mimulus alatus</i>

Class 3

<i>Alisma plantago-aquatica</i>	<i>Baptisia leucantha</i>
<i>Jussiaea diffusa</i>	<i>Hibiscus militaris</i>
<i>Samolus floribundus</i>	

Fall

Class 1

<i>Amaranthus retroflexus</i>	<i>Eupatorium serotinum</i>
<i>A. blitoides</i>	<i>Eragrostis hypnoides</i>
<i>Carex spp.</i>	<i>Bidens comosa</i>
<i>Eleocharis acicularis</i>	<i>Juncus effusus</i>
<i>Xanthium canadense</i>	

Class 2

<i>Acnida tuberculata</i>	<i>Bidens frondosa</i>
<i>Amaranthus graecizans</i>	<i>Commelina communis</i>
<i>Portulaca oleracea</i>	<i>Echinochloa crusgalli</i>
<i>Polygonum amphibium</i>	<i>Sagittaria latifolia</i>
<i>Bidens bipinnata</i>	<i>Eclipta alba</i>
<i>Penthorum sedoides</i>	

Class 3

Bromus secalinus	Gratiola virginiana
Cuscuta compacta	Mimulus ringens
Bidens cernua	Eleusine indica
Polygonum hydripiper- oides	Radicula armoracia

Both primary and secondary successions are represented along the river bank. Primary succession is observed below the mouth of entering tributaries where the bank is encroaching upon the river. Secondary succession is constantly taking place in the zones nearest the water's edge because of the almost annual destruction of the river bank plants. Ice jams along the river contribute largely to this destruction.

ISLANDS.—The flora of the islands is separated into two groups, that of the small and that of the large islands. The small islands have a maximum length of 800 yards, while the large islands vary from 800 yards to 3 or 4 miles in length, and may have a maximum width of 1 mile.

The small islands are characterized by a pioneer type of vegetation, and show the earliest stages in the hydrarch succession; the larger islands include a more advanced stage in this succession. The islands are generally from 1 to 3 feet lower than the floodplain of the mainland. This fact may explain why the succession on the largest islands does not reach the final stage of the climax floodplain forest.

The farming that was attempted on several of these islands met with the same or even less success than that on the unleveed floodplain. Abandoned farm areas showed present stages of plant growth in which the plant species corresponded with those of the primary plant succession of the islands.

SMALL ISLANDS.—The small islands are irregularly oval in shape, rounded at the upper end and tapering toward the downstream end. Since the upper end of an island is the oldest and wears away while the lower end builds up, zonation and well defined steps of plant succession were easily recognized.

Total tree counts were made in ten small islands and the results are recorded in figure 1. The lower tip of these islands has the

pioneer stage or first zone (A) of the plant succession. This first zone, which is identical with those found at the water's edge on the mainland, forms the outermost plant fringe of the entire island.

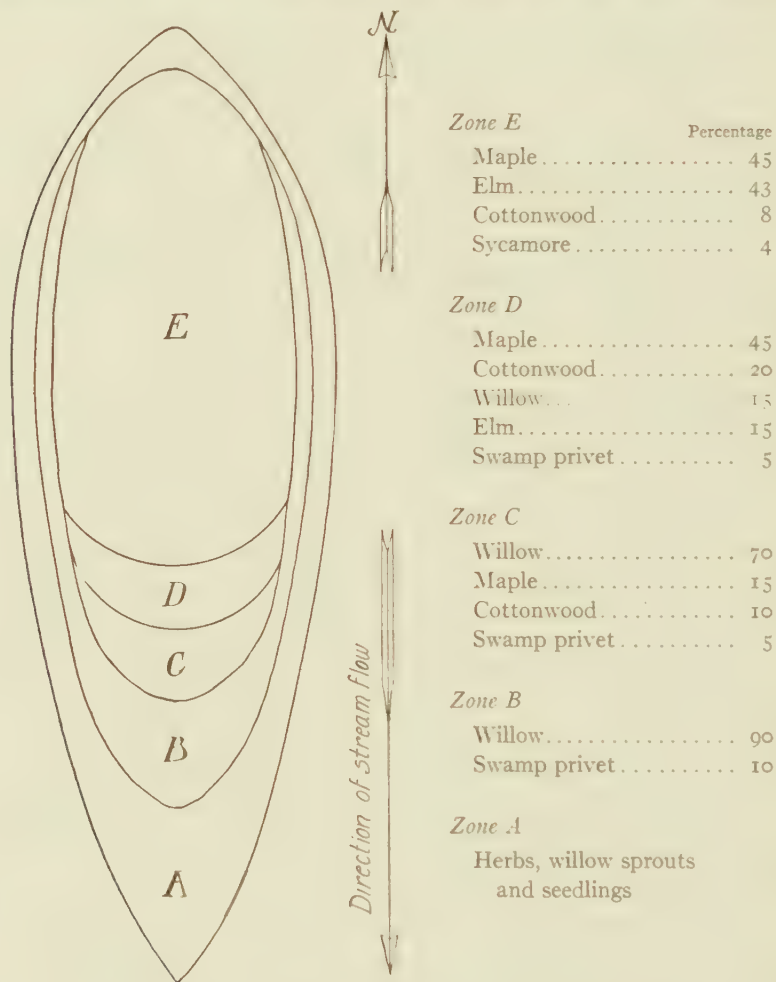


FIG. 1.—Floral analysis of small islands in lower Illinois River valley

Farther up from the lower end of the island occurs the second zone (B), which is a consociation of young willows with a few swamp privets and cottonwood sprouts. In the third zone (C) the per-

centage of willows decreases, cottonwoods become more important, and young maples appear. The fourth zone (*D*) exhibits two features, the occurrence of elms and the peak of cottonwood concentration. Willows decrease abruptly in this zone. Maples are found in approximately the same proportion on the upper part of the islands. In the fifth zone (*E*) the upper and interior three-fifths of the island has attained a condition of relative stability. Soft maples and elms are dominant, with the former slightly more numerous; cottonwoods decrease to 6–10 per cent of the stand; sycamores occur occasionally. The herbaceous cover differs little from that of the lower floodplain forest of the mainland.

LARGE ISLANDS.—At their lower end, the large islands exhibit the same general type of zonation as the small islands. The forest on the upper end differs primarily from that of the small islands in having an increased number of species and in having attained a state of relative stability. This most stable zone may be designated as the sixth zone or climax island forest. Although essentially the same species occur here as in the climax floodplain forest, the data in table VI show that the dominance index of some of the species in the two habitats varies.

The first five tree species listed in table VI are the most abundant in both the sixth zone or island climax forest and the climax floodplain forest of the mainland. The dominance index for these island species is somewhat less for the island than for the mainland species, except for the elm, which becomes the dominant tree. On the other hand, among the subdominant species the cottonwood, honey locust, and the sycamore attain a much higher dominance index in this habitat than on the mainland. Apparently the elm and the three species just given are more water tolerant and have a wider adaptation to soils containing less humus than have the other species. The hackberry, ash, hawthorn, river birch, swamp privet, and persimmon are subdominants which are more widespread and occur in greater numbers in the climax floodplain forest.

The herbaceous plants of the large islands are the same species as those found in the upper part of the small islands and in the low floodplain forest of the mainland.

LEVEES.—Plant succession on artificial levees in the valley has been discussed elsewhere (12).

TABLE VI

QUANTITATIVE EVALUATION OF TREES OF GREATEST FREQUENCY ON LARGER ISLANDS, AND COMPARISON OF DOMINANCE INDEX WITH FLOODPLAIN FOREST

SPECIES	NO. QUADRATS CONTAINING A SPECIES	AVERAGE NO. INDIVIDUALS PER QUADRAT	DOMINANCE INDEX	
			ISLAND FOREST	FLOODPLAIN FOREST
<i>Ulmus americana</i>	50	7.3	365	320
<i>Acer saccharinum</i>	50	7.2	360	418
<i>Carya illinoensis</i>	46	3.7	170	193
<i>Adelia acuminata</i>	37	3.0	111	133
<i>Quercus palustris</i>	25	4.0	100	153
<i>Populus deltoides</i>	34	2.9	90	24
<i>Celtis occidentalis</i>	41	2.1	86	114
<i>Gleditsia triacanthos</i>	26	2.0	52	32
<i>Platanus occidentalis</i>	31	1.5	47	Rare
<i>Fraxinus pennsylvanica</i> var. <i>lanceolata</i>	12	2.0	24	100
<i>Crataegus</i> sp.....	23	1.0	23	115
<i>Betula nigra</i>	13	1.0	13	69
<i>Diospyros virginiana</i>	12	1.0	12	26

TREES OF INFREQUENT OCCURRENCE

*Carya laciniosa**Acer negundo**Morus rubra*

Summary

1. Soil types found in Pike and Calhoun counties at the lower end of the Illinois River were correlated as far as possible with the plant communities growing upon them. The soils in the entire area studied have rather a wide variety of texture and type. There was a small range in the hydrogen-ion concentration of the soils. The variation of the pH of the upland soils was from 6 to 6.6; the floodplain soils was from 7 to 7.8. The pH of the talus slope was 8. The narrow range of pH seems to indicate that it is not an important factor in limiting the distribution of species.

2. A transect of the lower valley affords four general divisions: upland, bluff, transition region, and floodplain. Subdivision of these

results in ten major plant communities: upland pasture and old fields, upland forest, limestone bluff, hillside-talus slope forest, talus slope-floodplain transition forest, floodplain forest, floodplain prairie, floodplain lakes and sloughs, river bank, and islands.

3. The dominance index, derived from a quantitative study of trees 6 inches in diameter breast high and of shrubs over 6 feet in height, was used to determine the types of forest in this region. Herbs and some of the woody plants under 6 feet in height were studied, in the various habitats, in their spring, summer, and fall aspects.

4. The fragments of the original upland prairie that persist between the present areas of pastures and old fields contain few of the prairie plants that were formerly abundant. However, this upland habitat is second richest of all within the range in number of species when introduced ruderals are recorded.

5. The upland forest is a typical midwestern oak-hickory forest. Of all the plant communities, this upland forest ranks fourth in total number of species.

6. The limestone bluff has the smallest number of species of any of the plant communities studied and nearly all of these are herbs which appear in the spring.

7. The hillside-talus slope forest has as its dominant species the hard maple, the chestnut oak and the red oak. This plant community is the richest of all in both herbaceous and woody species. The explanation for this lies perhaps partly in the fact that it has been least disturbed by man, and partly because it is a favorable habitat for a great number of mesophytic plants indigenous to the central states.

8. The talus slope-floodplain transition forest lies above the zone of destructive floods. Cultivation and grazing have brought about the destruction of many of the native species. It contains species from both the hillsides and the floodplain. The elm, the sycamore, and the hackberry are the dominant trees.

9. The floodplain forest has more trees that have a dominance index of 100 or more than has any other forest studied. Soft maple and elm are the dominant trees. The small number of woody plants in the floodplain forest compared with other forests may be accounted

for by the scarcity of shrubs. Woody plants comprise 26 per cent of the total plants recorded for the floodplain forest, while hillside-talus slope forest and talus slope-floodplain forest have 33 per cent. The destructive action of floods doubtless accounts for the small number of perennial herbs and shrubs in this forest.

10. The floodplain prairie or savanna occurs on the broader floodplain areas of the Illinois River, generally a few feet higher than the floodplain forest; hence it is drier and less subject to flooding.

11. The lakes and sloughs have been greatly reduced in number and size by drainage. Both the permanent and temporary floodplain forest lakes and the floodplain prairie lakes show the usual zonation of plants in the hydrarch succession from the water to the forest or to the prairie climax. In general, the number of plant species is much smaller than in many lakes elsewhere, possibly because of the annual destruction of the plants by floods.

12. Four zones of plants constituted the hydrarch succession which occupies the river bank between the water's edge and the floodplain forest. Willow and cottonwood were the pioneer trees. In the third zone the willow occurred in several belts, each of which increased in age and height as the distance from the water's edge became greater.

13. The small islands have a zonation which is similar to that of the river bank. Except at the center of the islands, the habitat is relatively unstable. A quantitative study of the trees in each zone showed that there was a gradual change in tree species, and in the frequency of their occurrence from the less stable zone at the water's edge to the more stable zone at the center of the islands.

14. The lower end of the large islands has a zonation similar to that of the small islands. At the upper end the habitat is more stable, and there is a greater number of plant species than in this position on the smaller islands. A comparison of the dominance index of the trees in the climax island forest and the climax floodplain forest of the mainland indicates that the former has not reached so high a state of development as the climax forest of the mainland.

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